Phase I Report
Non-Destructive Analysis of Hydrogen in Nuclear Power Plant Materials

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Summary:

This research is focusing on a new technique patterned after the “notched neutron spectrum" technique for the measurement of hydrogen. During Phase I of this contract progress has been made in identifying a student who will use this research for his Ph.D. dissertation, designing two possible experimental configurations for the system, modeling the experimental system, designing and ordering the detector system for experimental measurements and identifying two research reactors for implementing the experimental system.

Objective I - Assign Student to Project

Mr. Liviu Groza has been assigned to this project for his Ph.D. dissertation. He joined the Nuclear Engineering program here at MU in 1997, has completed 36 credits, and has successfully passed our Ph.D. qualifying examination. He was involved in previous work funded by NRE, Incorporated, that established the original concept for this measurement approach. He also works as a Computer Specialist for the MU Hospital, which complements the computer modeling needs for this research.

Objective II - MCNP Modeling

Comprehensive modeling of the new system with MCNP is required to theoretically determine design parameters. This modeling will help define the energy of the incident beam, the design of collimators, beam stops, shielding, etc., and the geometry and configuration of the detector. During Phase I we have upgraded a personal computer and gained access to a workstation for running MCNP 4B. It is now installed on both, i.e. on the PC under Windows NT and on a SUN Ultra2 under Solaris 5.6.

Calculations have been made using the "base" experimental design (the model suggested in the research proposal) to determine background count rates in the detector, a parameter vital to determining the ultimate sensitivity of the system. Modeling is also nearing completion on a new, monochromator design which will take advantage of a larger incident beam area and is capable of delivering a more intense mono-energetic beam of neutrons. This higher beam intensity must be balanced against the potentially higher background created by this new geometry.

Objective III - Detector Design:

The physical and electronic parameters associated with the Pu-239 fission chamber must be specified to increase the sensitivity to hydrogen and reduce background noise. This work has been completed and the detector has been ordered from LND, Inc. Unfortunately, LND has informed us that they are having difficulty identifying a sub-contractor who can electroplate the Pu-239 to the necessary thickness. We are currently attempting to find another source for electroplating services so that LND can provide the detector. Discussions are currently ongoing with personnel from Oak Ridge National Laboratory and Los Alamos National Laboratory.

Objective IV - Monochromator Design:

The design, fabrication and testing of a monochromator unit to produce an intense beam of epithermal neutrons with the use of a packet of elastically bent silicon wafers is needed. Two designs have been identified: 1) utilizing the geometry suggested in the research proposal and 2) a new, azimuthially symmetrical design which could significantly increase the usable neutron flux on the sample. Both are possible from the standpoint of monochromator design, but must be evaluated with respect to neutron background at the detector position. Since the second design requires that the sample be placed in the beam line (with appropriate shielding to eliminate the primary beam from reaching the sample) it must be compared with the original design. (See Objective II above for progress on modeling this neutron background.)

Objective V - Reactor Beamport:

Although not part of the original proposal, we are considering alternate reactors for the source of neutrons. This has been precipitated by the difficulty of placing the experimental setup on one of the MURR's over-utilized beamtubes. Preliminary discussions have been held with Dr. Bernard Wehring, Director of the University of Texas Research Reactor, who has a beamtube available and is eager to work with us. This provides an option should implementation at the MURR become impractible.